

water used for cleaning into storing silicon wafers in order to effectively preserve a silicon wafer and to save on labor costs. In paragraph 2 of the Office Action, claims 6, 7 and 13 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Hayashida et al. in view of Suzuki et al. and further in view of Kern. The Office Action recognizes that Hayashida et al. and Suzuki et al. do not disclose silicon wafers having a hydrophobic surface, but notes that Kern teaches this in detail. According to the Office Action, it would have been obvious to one of ordinary skill in the art at the time the invention was made to include the non-attractive behavior of the silicon wafer towards water in order to show that the contaminants in the water are not on the wafer. In paragraph 3 of the Office Action, claims 8-11 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Hayashida et al. in view of Suzuki et al. and Kern, and further in view of Gill et al. According to the Office Action, Hayashida et al., Suzuki et al. and Kern fail to disclose the method of storing wafers into water immediately after polishing. However, Gill et al. is said to intrinsically teach such method in detail. According to the Office Action, it would have been obvious to one of ordinary skill in the art at the time of the invention to incorporate the method of storage after the wafer has been polished in order to preserve the wafer. In paragraph 4 of the Office Action, claim 19 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Hayashida et al. in view of Suzuki et al., and further in view of Ilardi et al. According to the Office Action, Hayashida et al. and Suzuki et al. do not disclose that the chelating agent has a chelate compound production performance not lower than that of NTA. However, Ilardi is

said to intrinsically disclose this by providing an example that one can be substituted for the other. Applicant respectfully traverses such rejections, particularly in view of the following remarks.

Of the 20 claims pending, claims 1, 3, 4 and 12 are independent. Claim 1, in its present form, reads as follows:

1. A storage water used for storage of a silicon wafer in water, wherein the storage water contains Cu at a concentration of 0.01ppb or less. [emphasis added]

Claim 3, in its present form, reads as follows:

3. A method of storing a silicon wafer in water, comprising the steps of preparing water or a chemical solution which does not cause degradation of oxide dielectric breakdown voltage due to copper concentration, and storing a silicon wafer in the prepared water or a chemical solution. [emphasis added]

Claim 4, in its present form, reads as follows:

4. A method of storing a silicon wafer in water, comprising the steps of preparing storage water containing Cu at a concentration of 0.01ppb or less, and storing a silicon wafer in the prepared storage water. [emphasis added]

Claim 12, in its present form, reads as follows:

12. A method of storing a silicon wafer in a storage solution, comprising the steps of preparing water or a chemical solution containing a chelating agent, and storing a silicon wafer in the prepared water or chemical solution. [emphasis added]

As defined in claims 1, 3, 4 and 12, the feature of the present invention involves storing a silicon wafer in storage water containing "Cu at a concentration of 0.01ppb or less" (claims 1 and 4), water or a chemical solution "which does not cause degradation of oxide dielectric breakdown voltage due to copper contamination" (claim 3) or "water or a chemical solution containing a chelating agent" (claim 12).

According to the features as set forth in claims 1, 3, 4 and 12, an object of the present invention is to provide silicon wafer storage water and a silicon wafer storage method which can prevent contamination during storage to thereby prevent degradation of oxide dielectric breakdown voltage (see lines 19-23 of page 5 of the present application), and the invention has the effect of preventing degradation of oxide dielectric breakdown voltage which would otherwise occur due to contamination by Cu contained in storage water (see lines 5-9 of page 10 of the present application).

According to the Office Action, Hayashida intrinsically discloses a similar solution that is used to treat silicon wafers. Hayashida describes that if Cu is a part of the solution, then the contaminants will be removed from the wafer (see lines 25-29 of column 1 of Hayashida). Hayashida also describes contamination of the wafer surface with metallic impurities, such as by a cleaning sequence, and problems arising in electrical properties, such as deterioration in oxide breakdown voltage and the like (see lines 52-61 of column 1 of Hayashida). Furthermore, Hayashida describes a cleaning solution containing Fe at a concentration of 0.01ppb or less (see

lines 43-45 of column 4). Moreover, Hayashida describes a cleaning solution with an added chelating solution (see lines 28-36 of column 3 and lines 1-11 of column 5 of the reference).

However, as admitted in the Office Action, the invention described in Hayashida only relates to a wafer cleaning process, and such reference neither describes nor suggests that a wafer is stored in a storage water, in the manner of the present invention. ⁵ The solution of Hayashida is used only to treat a surface of a wafer, but is not used to store a wafer in storage water.

Hayashida also describes that in the case where a wafer surface is contaminated with metallic impurities by a cleaning sequence, problems arise in deterioration of oxide breakdown voltage. ⁹ However, the reference does not describe the problem described at line 11 of page 3 through line 4 of page 4 of the present application that even if contaminants are removed from a surface of a wafer by cleaning, degradation of oxide dielectric breakdown voltage occurs when storing a wafer. Therefore, as described at lines 11-27 of page 11 of the present application, Hayashida understandably has no description that the degradation is mainly due to Cu concentration in a storage water.

¹ Thus, Hayashida describes a cleaning solution containing Fe at a concentration of 0.01ppb or less, but does not describe a cleaning solution containing Cu at a concentration of 0.01ppb or less. The Office Action states that Fe concentration intrinsically relates to Cu concentration, but it does not observe that

Cu concentration in a cleaning solution substantially affects oxide dielectric breakdown voltage.

Therefore, and with respect to a chelating agent, only the composition of a chelating agent used for a cleaning solution in Hayashida is like that of the present invention. Moreover, Hayashida neither describes nor suggests that a chelating agent is used to store a wafer in storage water, to prevent oxide dielectric breakdown voltage due to contamination of Cu in the storing thereof, in the manner of the present invention.

Accordingly, because Hayashida only describes a high purity water or chelating agent used for a cleaning agent, and does not describe that a wafer is stored in storage water and that a wafer is contaminated with Cu in storing a wafer, understandably Hayashida has no description or suggestion of the advancements set forth in claims 1, 3, 4 and 12 of the present application. As described, Hayashida completely differs from the subject matter of claims 1, 3, 4 and 12.

Suzuki et al. describes that after etching and cleaning, wafers are stored in an aqueous hydrogen peroxide solution. However, Suzuki et al. does not describe that wafers are stored in purified water containing Cu at a concentration of 0.01ppb or less and that wafers are stored in a chemical solution with an added chelating agent. As described therein, Suzuki et al. preferably denies that wafers are stored in purified water. As described at lines 50-61 of column 2 of Suzuki et al., even when "wafers washed with purified water are stored in their unmodified form in

purified water...the contamination caused on the surfaces of wafers after the elapse of a certain length of time can not be perfectly removed.” Suzuki et al. also describes at line 14-26 of column 3, as referred to in the lower part of the third page of the Office Action, that the reference teaches that the object of the invention is to provide a method for the storage of wafers in process for the purpose of preventing the contamination of surfaces of wafers which “adopts a relatively simply measure of temporarily storing the wafers in an aqueous hydrogen peroxide solution instead of the conventional measure of temporarily storing them in purified water or storing them in a clean dry air” (emphasis added). Suzuki et al. further describes, at lines 18-34 of column 5 thereof, that according to the convention method of storing wafers only in purified water, “the same contamination as heretofore observed occurred after the elapse of 30 minutes in an early case and after the lapse of 88 hours in a late case.” It is clear from these descriptions that the essential feature of Suzuki et al. is to store wafers in an aqueous hydrogen peroxide solution, and not to store them in high purified water containing Cu at a concentration of 0.01ppb or less, in the manner of the present invention.

Furthermore, Suzuki et al. neither describes nor suggests a method for adding a chelating agent to storage water. As aforementioned, because the essential feature of Suzuki et al. is to store wafers in an aqueous hydrogen peroxide solution, the reference neither describes nor suggests that other components are added, including at least a chelating agent, to storage water. Thus, claims 1, 3, 4 and 12 are submitted to clearly distinguish patentably over Suzuki et al.

The Office Action further states that the present invention would have been obvious to one of ordinary skill in the art, if a high purified cleaning solution including a chelating agent described in Hayashida is combined with a method for storing wafers in an aqueous hydrogen peroxide solution. As previously mentioned, however, Hayashida does not describe that the cleaning solution is used for storing wafers. Such reference does not suggest that a cleaning solution is used as storage water. Also, such reference does not describe that wafers are contaminated with Cu while storing them in water.

Furthermore, the essential feature of Suzuki et al. is the storage of wafers in an aqueous hydrogen peroxide solution. In other words, the reference teaches against storing wafers in a chelating agent or purified water, in the manner of Hayashida et al.

Consequently, one skilled in the art would not be led to combine Hayashida et al. with Suzuki et al. which teaches away from wafers being stored in the solution used as storage water.

The Office Action further states that storing a wafer in water between producing steps is described as being conventional in the present specification. Therefore, according to the Office Action, the present invention would have been obvious to one of ordinary skill in the art from the combination of Hayashida and Suzuki.

The present application describes, at lines 4-9 of page 2 of the specification, that a wafer is stored in water between production steps. However, as described at

lines 11-16 of page 3 of the specification, even when cleaning is performed, while the concentration of contaminant in the cleaning solution is controlled in order to produce a silicon wafer having a clean surface, a final wafer that has undergone all processing steps sometimes becomes defective in that the oxide dielectric breakdown voltage thereof is degraded.

Therefore, the inventors of the present invention analyzed the causes of generation of the degradation oxide dielectric breakdown voltage, and found that such degradation is caused by a conventional method of storing a silicon wafer, in a step preceding the cleaning step. Such degradation is produced especially when a silicon wafer having a hydrophobic surface coexists with a metal having an ionization tendency which is lower than that of silicon, as described at lines 2-10 of page 11 of the specification.

The inventors of the present invention found that degradation of oxide dielectric breakdown voltage occurs even when the concentration of Cu in the storage solution is on 1ppb or less. On the other hand, when the Cu concentration of the storage water is 0.01ppb or less, such degradation is not observed, as described at lines 21-27 of page 11 of the specification.

In view of the foregoing, the inventors of the present invention conceived of a method of storing a silicon wafer through use of water which contains Cu at a concentration of 0.01ppb or less in order to prevent degradation of the quality of the oxide film of the silicon wafer, as described at lines 19-23 of page 12 of the specification. Also, such inventors conceived of another method of storing a silicon

wafer in a storage solution which is prepared through addition of a chelating agent to water or a chemical solution in order to make the above-mentioned ions of metals, such as Cu, innocuous or harmless. This thereby prevents degradation of the quality of the oxide film of the silicon wafer, as described at line 4-10 of page 14 of the specification.

For the first time, the inventors of the present invention uncovered such findings, which are not prior art, and therefore even one of ordinary skill in the art cannot easily derive such findings from the prior art. For example, Hayashida describes that Cu or the like is removed from wafers in cleaning in order to prevent degradation of quality of the oxide film. However, the reference does not observe that a method of storing wafers in water affects degradation of quality of the oxide film. Also, Suzuki et al. describes that when wafers are stored in water, the wafers are contaminated. Therefore, conventional storage water causes the contamination because of not using the storage water with Cu at a concentration of 0.01ppb or less, in the manner of the present invention.

Consequently, and as described in the specification, if storing of a wafer in water is known in the prior art, the combination of Hayashida and Suzuki et al. cannot lead to the present invention because storage water with Cu at a concentration of 0.01ppb or less or storage water with an added chelating agent, and storage methods using such, are recognized for the first time based on the findings described above.

The present invention has an unexpected result which is not described or suggested by Hayashida or Suzuki, that the degradation of oxide dielectric breakdown voltage of a silicon wafer can be prevented, where the silicon wafer is stored in water between producing steps.

The response to applicant's arguments which is set forth at the end of the Office Action requests a narrowing of the claims in view of the prior art including art which discusses storage of silicon wafers, and including Japanese patents which have not yet been applied. However, based on the prior art already cited and particularly the art applied in rejecting the claims, applicant believes it to be clear that the present invention clearly distinguishes patentably over such prior art, and that the claims patentably distinguish over such art in their present form.

Again, independent claims 1, 3, 4 and 12 are submitted to clearly distinguish patentably over the prior art for the reasons discussed above. Claims 2, 5-11 and 13-20 depend, directly or indirectly, from the independent claims, and contain all of the limitations thereof, so as to also distinguish patentably over the prior art.

In conclusion, reconsideration and allowance are respectfully requested.

If for any reason the Examiner finds the application other than in condition for allowance, the Examiner is requested to call the undersigned attorney at the Los Angeles telephone number (213) 337-6846 to discuss the steps necessary for placing the application in condition for allowance.

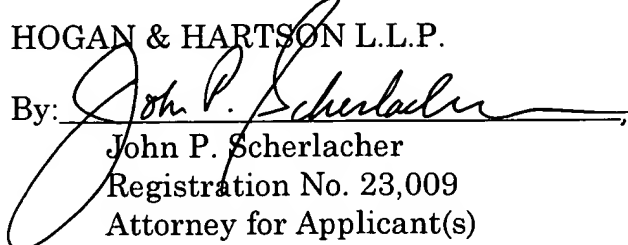
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Respectfully submitted,

HOGAN & HARTSON L.L.P.

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